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Plenty of Planning, Scanty Guidance: Evaluating the Implementation Degree of the General Master Plan in the City of Tampere, Finland

Kaisu Kuusela [1,*] and Jenni Partanen [1,2,*]

[1] School of Architecture, Tampere University, PL 600, 33101 Tampere, Finland
[2] Academy of Architecture and Urban Studies, Tallinn University of Technology, Tõnismägi 14, 10119 Tallinn, Estonia
* Correspondence: kaisu.kuusela@tuni.fi (K.K.); jenni.partanen@taltech.ee (J.P.)

Abstract: Digitalizing cities has become increasingly complex and difficult to control despite advanced computational tools. The comprehension of emergent, dynamic agent–pattern interaction is limited. Studies show that the implementation of large-scale plans occasionally fails to meet expectations due to uncertainty in urban actor processes and institutions. Theories of complexity and resilience reflecting urban unpredictability and non-equilibrium enable understanding and planning methods for guiding actors. We explored empirically via close reading and spatial analyses the ability of the traditional master planning instrument to steer the actor allocation in Tampere, Finland. The plan apparently failed to appropriately guide the actors, who formed self-organizing patterns colliding with the planning aims enabled by deviations and lower-level planning instruments. The planning mode was either enabling or reactive. We recognized three types of self-organization: single-point attraction, emergent type, and location-based self-organization. Self-organization was the major force behind urban transition. Only certain large-scale projects in the city center somewhat complied with the planning aims, however through negotiations. We proposed planning solutions encouraging and guiding self-organizing patterns by recognizing complexity in strategies, and with loose plans, constant monitoring, correcting, and experimenting in planning. The results participate in building more general knowledge of planning considering self-organizing urban dynamics and provide applications for urban planning.

Keywords: urban planning and governance; complex systems; sustainability; resilience; self-organization

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Citation: Kuusela, K.; Partanen, J. Plenty of Planning, Scanty Guidance: Evaluating the Implementation Degree of the General Master Plan in the City of Tampere, Finland. *Sustainability* **2022**, *14*, 15197. https://doi.org/10.3390/su142215197

Academic Editors: Frank Othengrafen and Daniel Galland

Received: 3 October 2022
Accepted: 2 November 2022
Published: 16 November 2022

1. Introduction

In recent decades, we have witnessed urban regions becoming increasingly complex, interlinked systems that are hard to control with traditional master planning [1–3]. Moreover, currently ongoing unforeseen digitalization makes the resulting technology mediated cities even more complex. In addition to more traditional, small-scale CAD tools and algorithmic design applications, the novel methods we increasingly use to plan and guide cities range from geodesign (GIS) and digital participatory tools to sophisticated simulation models, procedural modeling and CIM for analyzing, planning, and assessing potential urban futures, combining soft and hard methods [4–8]. Furthermore, digital twins consisting of building information models (BIM) provide agile and interactive data storage for many aspects of urban planning; artificial intelligence (AI) and machine learning are commonly used in modeling and estimating nonlinear aspects of urban land and mobility dynamics [9–12].

However, despite the attempts to renew planning with strategical approaches [13], the urban paradigm behind the current city planning in many cases still draws from a rational–comprehensive model and stresses control, simple optimization and the efficiency of urban activities [14]. This view implies an assumed controllability, predictability, linearity and equilibrium of urban systems colliding with the profound uncertainty of complex reality [10,14].

The comprehension of complex changing interactions between urban agents, firms, individuals, institutions, and NGOs—and agents and urban environments within planning systems—is still limited. The cumulative patterns and trends emerging from their interaction may appear as surprising ruptures in the expected linear behavior of the urban system the planning attempts to guide [10,15,16]. While planning scholars and many individual planners and decision makers are aware of such an autonomous nature of urban dynamics, planning systems are still in progress to be able to accommodate it [17–19]. In the era of ubiquitous digitalization accelerating this complexity and unpredictability, the uncertainty becomes tangible and requires a more profound shift in how cities are conceived [20,21].

Previous research indicates that there is a low level of success in the implementation of plans due to the inherent uncertainty in urban processes, institutions, and actors' behavior [3,22–27]. As a traditional planning system does not purposefully recognize or encourage dynamics emerging from actors' dispersed decision making, starting from the 1990s, negotiation has become an established practice in deviations from the plan considered necessary for the adaptability [17,18]. This often leads to an arduous, non-transparent, and inequal system in planning [23,28]. Despite the communicative shift and advanced participatory tools increasingly used in urban planning [29], current planning for digitalizing cities has even been suggested to just reproduce the neo-liberal paradigm instead of offering more inclusion [30]

The complexity science of cities is an established theoretical frame that stresses the role of dissipated decision making of urban actors and system's evolution through infrequent ruptures [31] while embracing the communicative paradigm [32]. Particularly, spatial pattern formations resulting from actors' self-organization, for example the clustering of similar actors, is known to be important for urban economic and socio-cultural processes [33]. Complexity and especially self-organization has formed the basis of a variety of critical planning (theoretical) innovations [1–3,10,34]. Complexity planning indicates, inter alia, the mismatch between traditional master planning instruments and the reality of constantly becoming autonomously evolving cities.

A systematic, critical empirical study of the implementation of master plans and their relation to the self-organizing behavior of economic activities has previously been limited [35], particularly in the Finnish context [36]. With this article, we intended to participate in this quest for building more tolerant planning tools capable of guiding urban systems and enrich the complexity planning for a wider spectrum of practical applications. To approach these challenges, we also draw from another related and systems theoretical source, resilience theory, originally from the academic discipline of ecology, which embraces similar views toward complex ecosystems. What is more, this ecological perspective suggests an applicable approach for planning complex ecosystems in nature, nurturing the systems' capacity to adaptation and renewal. Essential in both is a self-organizing order that emerges autonomously from actors' interaction [37–39]. We suggest that it is possible to learn from complexity and resilience thinking that emphasizes small maneuvers, constant evaluation, and swift reacting to a preferred course of action to overcome the pitfalls in traditional master planning.

In this article, we explored the ability of the general master planning instrument to steer the allocation of urban economic and other actors constantly searching for the best locations for their maximal advantage between the years 1998 and 2014. The research was carried out in the city of Tampere, southwestern Finland. For evaluating the patterns and behavior of the agents, we applied a complementary framework of complexity and resilience thinking. We ask to what extent do the locations of urban activities follow the spatio-functional objectives that are set in the general master plan in the case of Tampere? Which types of self-organizing behavior can be recognized among actors? How should the planning be developed to support the urban evolution and build resilience for more sustainable cities?

We first studied the autonomous location processes and resulting patterns of a variety of industries and housing across the city of Tampere. These perceived actor patterns were then compared with the master plan, and with more flexible, nested lower-level planning instruments (i.e., deviation decisions and local detailed plans), as well as the objectives of the master plan. We classified the types of actor-based processes and patterns that could be recognized in the city and the actual means of how they were supported, enabled, or hindered by the general master plan and planning instruments in general. Finally, we suggested guidelines for planning that better considers the complexity, self-organizing dynamics, and uncertainty of cities.

2. Theoretical Framework

Until recently, despite the groundbreaking communicative shift in the 1980s and 1990s, and the revolutionary post-structuralist ideas of the shift of the 2000s, urban planning has been in many cases rooted in the rational comprehensive thinking of the 1960s. This thinking was most prevalent in the zoning plans of that era [18] that stressed (erroneously) similarities between scientific and planning processes, and most importantly, the decentralization and spatial separation of functions leading to suburbanization [40] with the underlying idea that actors would follow the plan. Although the dissipated decision making leading to self-organization of all urban actors has been understood for decades [1,2], many attempts to tame these seemingly chaotic dynamics were based on the similar stance. For example, in the case of Tampere presented later in this article, the attempt to apply a partial master plan as an allegedly more flexible instrument to respond to autonomous urban change was doomed to fail, since the premises of the partial master plan—top–down allocation of activities, although complying with the existing uses, and non-adaptivity—did not differ from those of the local master plan, resulting in further collision between actor based processes and the plans, and new problems with increasingly fragmented urban landscape [41].

Complex adaptive systems today form an established framework for urban studies and planning [2,3,10]. These approaches emerged within the natural sciences in the turn of the 1970s among scientists who studied physical–material systems with nonlinear features previously considered typical of biological or chemical entities. Soon, it was noticed that self-organization, emergence, fractality and alike were more general phenomena, appearing in many types of complex systems, including human systems [2]. Complex theoretical stances have been applied in various fields from economics to social science, urban studies and planning for their capacity to embrace irreversibility, recursiveness, and uncertainty in city dynamics [42,43]. Simultaneously, in the late 1960s, another systems theoretical approach, resilience theory, emerged within ecological sciences and has later on also been applied in urban studies [44,45]. Ecological resilience theory stresses the systems' ability to absorb perturbation to an extent until a qualitative shift occurs, and the capability to recover from crises through self-organization. Both complexity and resilience thinking contested the prior understanding of many fundamental aspects of dynamic systems, which previously implied equilibrium disregarding trans-scalar dynamics and the intrinsic uncertainty of these systems [44].

Both complexity and resilience argue that the constant autonomous change in open systems is discontinuous, experiencing sudden qualitative and irreversible changes, and that rare events at critical times trigger these in an unpredictable manner. Moreover, both recognize the necessity of constant energy flow through systems and that systems scale up nonlinearly—large and slow variables control the small and fast ones, and this feedback may be reverted at times; and that systems operate far from equilibria, they may have multiple equilibria, or they experience a disappearance of equilibrium [46]. Systems are constantly balancing between stabilizing (maintaining productivity and perceivable cycles; 'dynamic steady states') and destabilizing forces (maintaining diversity, resilience, and opportunity; 'mathematic chaos'). In this article, we consider that the two provide complementary explanations for certain (from a planning perspective) ambiguous qualities of cities. Such features would be actors' dissipated location decisions and unpredictable patterns emerging from these and the resulting spatial dynamics of urban activities.

2.1. Justifying the Ecosystem Metaphor

The concept of an ecosystem includes both natural systems' components and human systems (social, economic, and cultural) coupled with it. On the one hand, cities *are* ecosystems: they are an intrinsic part of networks of nested networks of human-natural systems [47–49]. On the other hand, an ecosystem refers to an assemblage of entities interacting with each other and with their physical environment within a specified area [48], making urban systems and the ecosystems in nature metaphorically similar.

Embracing metaphors extends and renews our comprehension of reality. Metaphors can transfer an idea or an approach to another realm and help build models of thinking in another field [49]. Metaphors from nature are not new in urban design and planning. Early examples from the early 20th century have been heavily criticized for their simplicity and formalism. However, the recent mental models emphasize the deeper ontological or functional similarities between natural ecosystems and cities instead of their sheer resemblance to natural forms. Both concern the systems dynamics of interlinked forms and processes interacting in a circular manner. Actors produce spatial configurations, which then start to restrain the actors and so on [48–50]. Complexity thinking can provide tools for understanding and managing this continuous two-fold process [50]. At present, the ecological metaphors have become well established within the urban discourses, emphasizing change. These have concentrated on processual analogies such as urban evolution, metabolism, self-organization, and network city [2,51,52].

Adopting concepts of ecosystem or ecosystem resilience helps to integrate ecological and urban studies as well as urban planning. In metaphorical use, they provide a novel perspective for a new reading of cities and their formation. In this article, with the emphasis on spatial planning, we follow the metaphorical line of thought—the necessity to improve the quality of life and to support the processes promoting this [52,53]. While doing this, we embraced the concepts prevalent in the discipline of ecology and ecosystem studies, such as resilience, soft, redundancy, CAS, and systemic thinking for their proved applicability in urban planning.

2.2. Embracing the Ecosystem View

An (urban) ecosystem has typically its own delicate dynamic internal structure. Disturbing such dynamic stability—for example, an autonomously emerged actor network—could be irreversible [7]. Replacing natural variability with a request for linear growth often reduces resilience, causing unpredictable irreversible outcomes, leading to loss of functional diversity, and reducing the ability to adapt to change via absorbing shocks or recovering from crises through self-organization. In nonlinear, urban and other ecosystems, seemingly irrelevant "species" may create a buffer capacity for the system to recover from crises to keep the whole system alive [20].

Moreover, both CAS and resilience theory imply that systems evolve though ruptures and reorganizations oscillating with more static states of growth. For example, in cities, certain "fallow areas" emerge from infrequent transitions in urban economics. This decay of workplaces or industrial areas and infrastructure affords breeding grounds for new actors helping the recovery of economic and cultural activities after shocks [52]. Such self-organizing areas need recognition and delicate support.

Soft redundancy is a process through which biological ecosystems regulate their balance, as each operates over an overlapping range of conditions and with different efficiencies of response [20,54]. For complex systems, this provides an alternative to rigid control. It implies that under uncertainty, risks and benefits are spread widely to retain consistency in performance independent of fluctuation in the individual species. In nature, variability is self-regulated by encouraging functional diversity, which enhances the robustness of the process and resilience, and by operating near the edge of instabilities, promoting new qualities and adaptive capacity [55]. In resulting circumstances, the system can adapt to changes and is capable of necessary qualitative transitions.

In the city, supporting diversity in agent networks and the above-mentioned dynamics improves the overall survival and progress of cities. For guidance, a combination of flexible or tolerant regulation encouraging redundancy and well-addressed restrictions, early signals of error built into incentives for corrective action, and continuous experimental probing of the change in the external world would be required. (It is noteworthy that since the top–down view of rational, comprehensive planning assumes a perfect knowledge of linear city dynamics, understanding complex unpredictable interactions between agents and agents and environment is limited. Certain dynamics and even resilience are however implied, but often in a mechanistic manner. Instead of this 'engineering' resilience approach emphasizing continuous production and controllability, we should adopt the ecosystem and evolutionary resilience presented in this article stressing constant change, uncertainty and multiple equilibria, and system's evolution. The engineering resilience appears dominant in current thinking in planning: variability and diversity or activity, and uncertainty of conditions are not typically encouraged by the planning system).

Within the theoretical framework presented above, we studied the implementation of a local master plan in Tampere, Finland. Our hypothesis was that the traditional master planning instrument is incapable of adapting to actors' requirements necessary for urban dynamics, and the planning system has inappropriate and heavy mechanisms to respond to these emergent urban processes for viability of the city. We explored and classified these mechanisms and related actor processes, and we suggested guidelines for more adequate organizing future planning for complex, sustainable cities.

3. Materials and Methods

In this research, the development of Tampere was studied from the end of 1999 to the end of 2013. This time frame was selected for it reflects the situation before the new master plan, for which the evaluation started in 2014. This decision was made in order to cover the time period between the ratification of the master plan (1998) and the moment in which the City of Tampere started to react to the resulting urban processes by revising the master plan by 2014. Our aim was to track the impact of the 'autonomous' processes inflicted by the 1998 master plan, before those dynamics was affected by the city master planning office agency. The data cover the local detailed plans (site plans) between 1999 and 2013, resulting in local detailed plan amendments, and 161 decisions to deviate from those approved within 2003–2013 (no earlier records were available). Detailed site plans for the industrial areas were embraced in the inner city 1998 plan before the approval of the local master plan. Furthermore, the data included the building permits granted between years 1999 and 2013. (The material was analyzed in an evaluation project carried out in 2015 on the master planning of the city of Tampere administered by Pia Hastio). These data regarded the industrial and working areas, the service areas, and the development of the urban centers. For the population metrics, we used the Facta-register (City of Tampere) and the Finnish Monitoring System of Spatial Structure and Urban Form (YKR) material from 2000 and from 2013.

The focus of this study was qualitative, as we analyzed the literary material (plans, related reports, and justifications for the changes applied) through close reading. In addition, spatial analyses methods (GIS) were used to compare the spatial relations of the plans and implemented projects, along with the range of their volumes. Finally, we classified these data concerning actor types (service, industry, housing), planning situation (infill areas, other permitted non-encouraged locations, deviations), and resulting configuration, according to the type of self-organizing processes that occurred to recognize typical patterns in plan–activity correlations. Regarding the land uses, this study concerned housing, public and private services and industries. For retail, in Finland, the allocation and steering of the large-scale retail units (over 2000 m^2) fall legally under the Regional Landscape Plan and are not considered in the General Master Plan evaluated here.

The Case of Tampere

Tampere, located in southwestern Finland, is the center of the second largest urban region in the country. During the period of observation 1999–2013, Tampere was growing steadily and extensively from 191,000 to 218,000. The local master plan for Tampere was completed in 1998(Figure 1). Its main purpose was to prepare for regional growth: to control the infill development especially regarding housing and to steer the location of economic actors to potentially compete with other regions, particularly the Helsinki Metropolitan Area, which is the largest and most impactful economic region in Finland. The target year for the local master plan was 2020. The local master plan endeavored to promote a coherent and compact city structure.

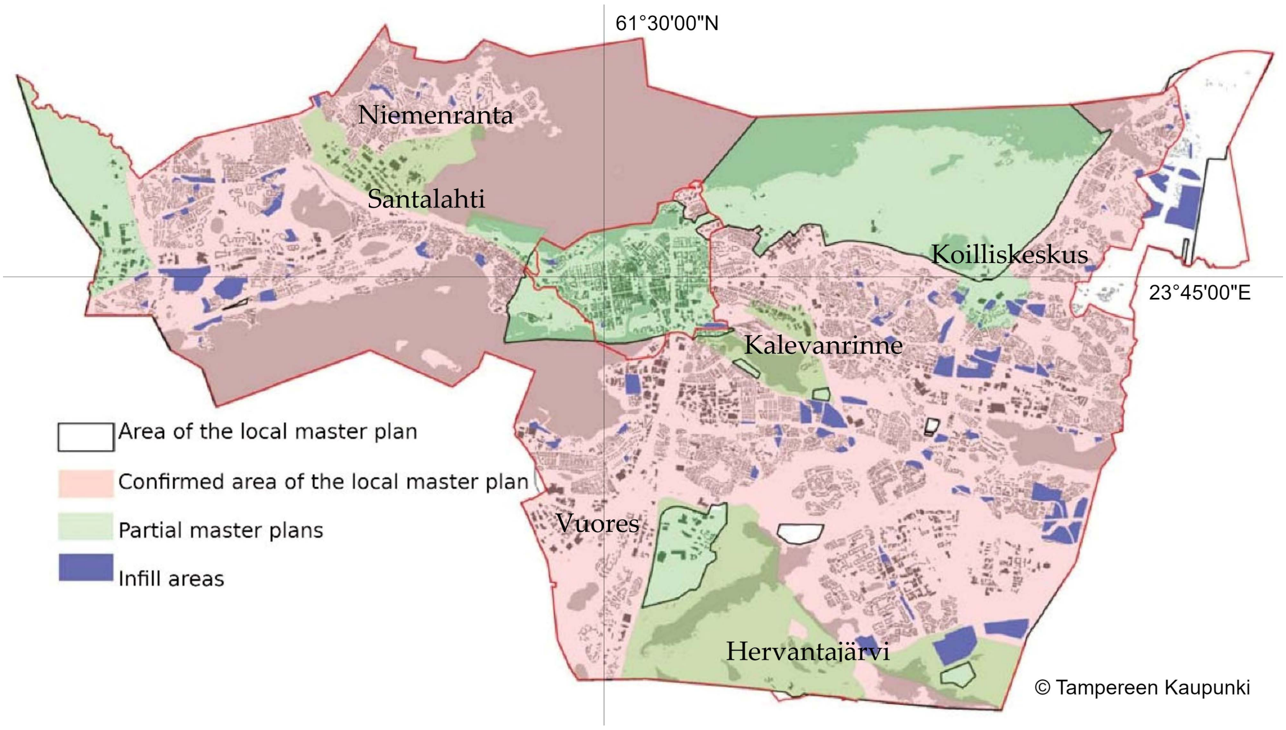

Figure 1. Tampere Local Master Plan area. Locations of the Master Plan 1998 housing infill areas and partial master plans completed after the master plan. They enabled new commercial activities and renewed old industrial areas according to the ongoing urban processes not considered in the master plan. In addition, partial master plans aimed at establishing the urban greenspace. Reprinted with permission from Ref. [56]. The City of Tampere.

4. Tampere Planning Progress: Aims, Implementation and the Resulting Situation by 2014

4.1. Planning for Housing Sector

In 1998, the population of Tampere was estimated to increase to 210,000 inhabitants by 2020. In the master plan, the aim was to channel this growth to the infill development areas, which entailed space reservations for approximately 29,000 inhabitants. Overall, 4000 hectares of land was designated for housing; hence, 32% of the inner-city land area was covered by the local master plan. The total volume of the new residential areas included in the local master plan and in the subsequent partial master plans was less than 650 hectares. The master plan also permitted approximately 44,000 new residents in these areas.

While the master plan did not designate infill development within the existing residential districts, it nevertheless permitted some new housing in these areas. Housing production was also permitted in the central urban areas (areas for center activities). Quantitative planning objectives were, however, only set for the infill development areas. In addition, during the 2000s, the housing reservations in the 1998 master plan had been complemented by partial master plans, and the total housing volume reserved was doubled.

Since the mid-2000s, seven partial master plans for housing were completed in the inner-city area (Figure 1). In this study, six valid partial master plans were explored, all of which propose a considerable increase in residential construction in the planning area. These areas are partial maters plans of Koilliskeskus, Niemenranta, Santalahti, Kalevanrinne, Vuores, and Hervantajärvi, ratified in years 2004, 2009, 2008, 2011, 2005, and 2014, respectively. The implementation of these areas was slow. In 2013, the share of housing construction achieved in areas covered by partial master plans was 8.2 hectares. The total number of inhabitants in these areas was 1250. At the end of 2013, there was an allocation for about 20,000 residents in the areas covered by the partial local master plans (Figure 2). In addition, certain areas designated for service activities, industry, or as survey areas in the local master plan were converted for housing by means of local detailed plans. The total area of housing plots in the infill area was 93 hectares with 8900 residents at the end of 2013.

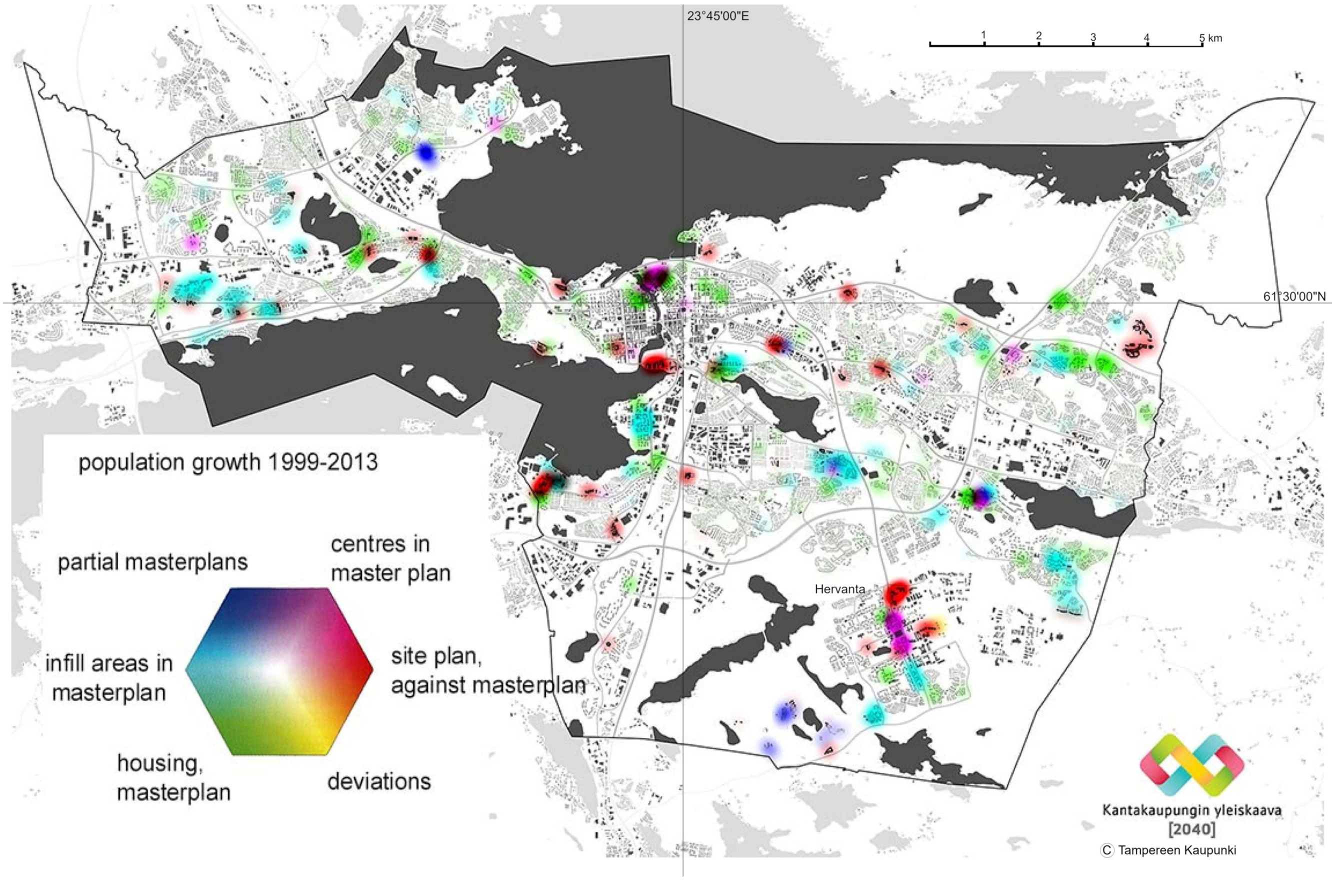

Figure 2. The population increase in housing construction from 1999 through 2013 based on the various infill development processes. Infill development has been implemented through various processes in areas where the growth pressure has been great, such as the city center and the suburb of Hervanta. On the other hand, there are extensive zones in the inner city area where the population has not increased through any of the processes (cyan, green spots), while remarkable volume was implemented via site plans (red spots). Image: City of Tampere/Jouko Järnefelt. Reprinted with permission from Ref. [56]. The City of Tampere.

4.2. Planning for the Business, Industrial and Services Sector

In 1998, there were 95,700 workplaces in Tampere. The planning goal was to improve the operating environment for firms and to diversify the economic base. The 1998 master plan aimed at bringing 15,000 new jobs to Tampere by the turn of the 2010s, anticipating roughly 110,700 workplaces by that time. The shift from industrial to service jobs had already started in the 1980s in several major industrial areas in Tampere, following global trends. At the time of the approval of the master plan in 1998, the industrial jobs, particularly in the city center, had been gradually replaced increasingly by service jobs. At the end of the 1990s, mixed use in the industrial areas concerning retail and production also became permitted resulting from initiatives of several small local enterprises.

Several working place and industrial areas were developed by means of a more flexible instrument, partial master plan geographically covering only the district at issue, consolidating the progress of these areas to unique directions already emerging from their internal, actor-based processes. For example, the Myllypuro partial master plan (2009) focused on production-dominated industrial activities and the Lahdesjärvi partial master plan (2013) compromised with a combination of services and industrial workplaces.

The aim of the local master plan was to locate service areas in a systematic, accessible manner to enable the balanced development of a wide range of public and private services throughout the city area. Focus was on smooth connections by all modes of transport. The local master plan organized the public and commercial services hierarchically into neighborhood, local, district, and main center services. Two partial master plans were presented after 2000 to develop this service network. Four other lower-level mixed-use central areas were designated in the Tampere master plan. These centers formed a hierarchical framework for the city's private and public service network. In addition, both public and private services were permitted in certain mature industrial areas and in areas reserved for public services. The implicit aim of these general notations was to prevent an unpreferable uncontrolled location of large retail units in these areas. Consequently, the 1998 local master plan and the following partial master plans embraced 2395 hectares of working areas, centers, and service areas. This was 18% of the land area covered by the master plan.

5. Comparative Observations of the Processes and Plans

Next, we explored how the implementation processes differed from planning objectives and the types of spatial configurations that resulted in the cases of housing development, infill areas, old residential areas, sub-centers, and working place areas.

Housing development was slow in areas covered by the partial master plan. By the end of 2013, residential areas implemented in the contravention of the master plans had almost nine times more residents than those constructed based on partial master plans. In 1999–2013, almost 30% of the population of Tampere was living in housing areas produced contrary to the local master plan. A comparison of the infill development areas implemented and included in the 1998 local master plan and the housing implemented outside the residential areas included in the local master plans is presented in Figure 3 and Table 1.

It appeared that local master plan objectives for steering housing construction to infill development areas were modest on account of spontaneous infill development in the suburban centers and in the existing residential areas. These were legally permitted but not promoted. The total of 134 hectares of the local master plan's infill development areas was designated for housing by local detailed plans. At the end of 2013, in these areas, the population was 14,000—less than half of the expected number.

In the old residential areas, densification had been implemented by means of local detailed planning dividing large plots (ca. 1500 m^2) typical for 1950s detached houses. Site planning also enabled the swift transformation of small service plots into housing plots within these areas. Between 1999 and 2003, almost 200 hectares of plots located in old residential areas were built up to house over 16,000 new residents. The spontaneous densification of the old residential areas appeared as a most significant response to population growth. This only occurred in the areas with detached houses but not in the areas of apartment blocks. The land ownership conditions naturally affect the pace of implementation: fragmented landownership of apartment house plots probably delayed the process.

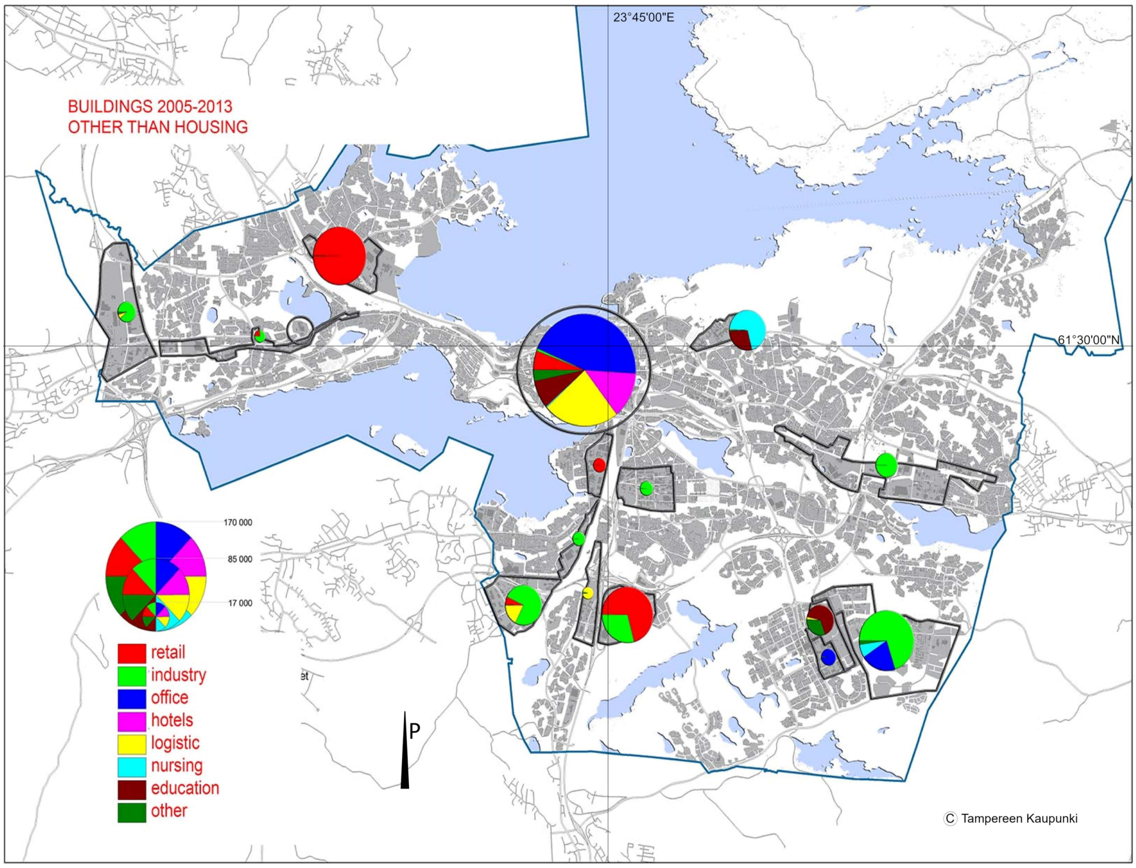

Figure 3. Buildings completed in the industrial, working, service, and central areas included in the local master plans between 2005 and 2013. The city center clearly stands out from the rest of the city as the most diverse construction area with the most significant volume. Some of the construction in the city center is linked to the publicly funded improvement of conditions such as the development of traffic systems. In other parts of the inner city, construction is less diverse and is smaller in volume. Image: City of Tampere/Maikki Jokinen. Reprinted with permission from Ref. [56]. The City of Tampere.

Table 1. Housing construction from 1999 through 2013. A comparison of various processes. One-third of the city's growth took place in the infill development areas specified in the local master plan. The densification of old residential areas was more efficient. One-fifth of the city's growth took place outside the residential areas. The total volume of new construction exceeded the dimensioning specified in the master plan. The focusing of construction on housing blocks creates pressure for the same efficiency in infill construction as in city center areas.

A Comparison of Processes Conducive to Housing Construction						
	Infill Development *	**Residential Areas ***	**Centers (C Areas) ***	**Construction Implemented/Partial Master Plan Process**	**Housing Outside the Residential Areas ***	**Deviations**
The Area (m^2)/Local Detailed Planning Units	1,343,500	1,990,200	190,000	82,300	646,000	66,350
New Residential Buildings 1999–2013	1186	1630	84	84	422	3
Implemented Floor Area (m^2)	642,545	795,325	253,559	66,047	480,763	8412
Inhabitants (2013)	14,174	16,217	3952	1246	8938	166
Inhabitants/m^2	1/45	1/49	1/64	1/53	1/54	1/51
Average Plot Efficiency	0.48	0.40	1.33	0.80	0.74	0.13

* Reservations included in the local master plan for the inner city 1998.

Housing construction was active in the city center and in local centers in the eastern part of Tampere. Between 1998 and 2013, the city center areas received approximately 1600 new residents, and in general, the population in central areas of Tampere increased by 4000 residents. Otherwise, inner-city center development was geographically uneven. Only the eastern-side centers and the city center gained inhabitants, while centers in western Tampere suffered from a complete lack of development. This caused socially unbalanced population dynamics and presumedly affected house prices. In addition to existing strong centers, focal areas for housing development were those near good transport connections and the attractive locations by the shores of the large lakes.

5.1. Features and Processes in Working Place Areas

Regarding industrial areas, three major areas for manufacturing industry were covered by the local master plan: Myllypuro, Rusko, and Etu-Hankkio (Figure 4). For most of the time, the site plans in these areas were not adjusted to follow the master plan. Instead, site plans were most often updated reflecting actual projects and other planning needs emerging from the private actors. For example, in Myllypuro, many local detailed plans had been ratified as a technical procedure to permit uses already implemented in traffic areas in a piecemeal way. As these fragmented changes cumulated, a partial master plan was created to cover these and to reflect the extension potential for the already expanding area. In Rusko, the industrial area had expanded remarkably contrary to local master plan by means of a series of site plans. Moreover, a new, significant massive industrial and office project described by the City as a "landmark" was later launched in the area, again clearly in contradictory the aims of the master plan. In Etu-Hankkio, the uses had gradually been becoming more diverse within the existing structure within the framework of sufficiently loose and tolerant plans, enabling transformation of the area's profile from industry toward a mixed-used area.

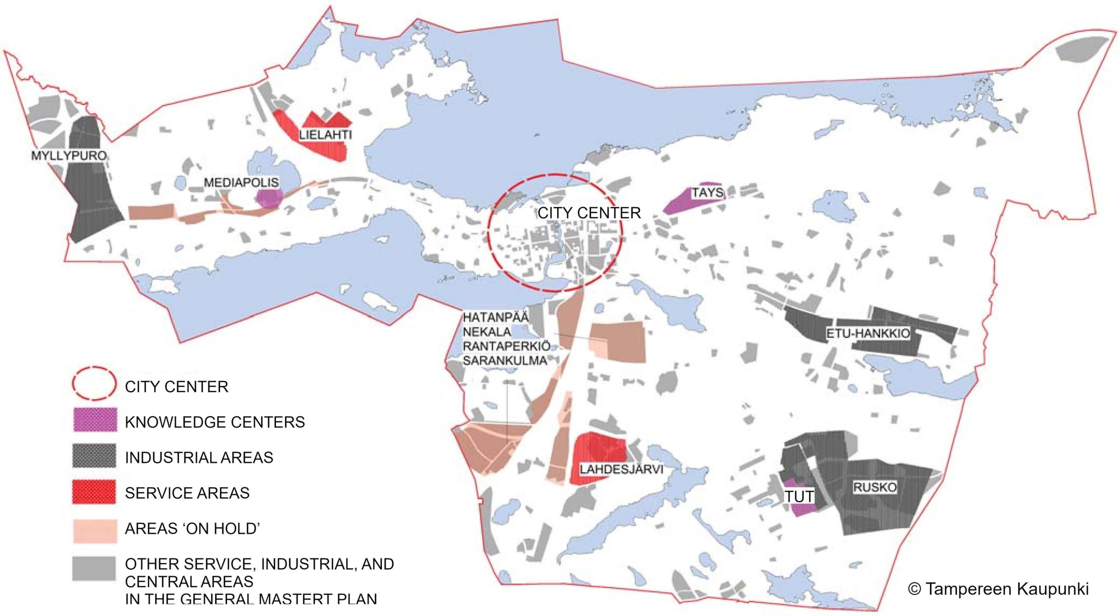

Figure 4. Locations of the most important working place areas in Tampere. Functional profiles emerge as a conclusion of the analysis of development processes in different areas. Reprinted with permission from Ref. [56]. The City of Tampere.

Overall, the trend was a transition from industrial uses toward services at a swift pace, leaving the city planning a reactive role. Of all planned areas formed by means of the local detailed plan amendments in the industrial, business, and service areas, 61% of site plan changes concerned increasing the volume of business premises (in m^2) in the plan area. Of these, 35% were related to converting an industrial plot for commercial use or increasing the volume of business premises on an industrial plot that has been designated for industrial functions.

5.2. The Lielahti Process

The most outstanding example is Lielahti, which is a mature industrial and warehouse area. Starting from the 1980s, a significant share of industrial buildings and warehouses in the area had transformed for service and commercial uses initiated by the actors (Figure 5). This progress was recognized and noted in 1998 in the local master plan, and a partial master plan was created in 2006 to reflect the already ongoing dynamics and patterns. The Lielahti area was defined as a district center, permitting not only large retail units—that were already settled in the area—but also the conversion of warehouses for commercial use, and in certain parts even allowing residential use. These maneuvers completed the autonomous transformation progress that initially emerged from the distributed actions of local actors seeking a competition advantage from locating near similar actors and had been implemented through deviations and site planning.

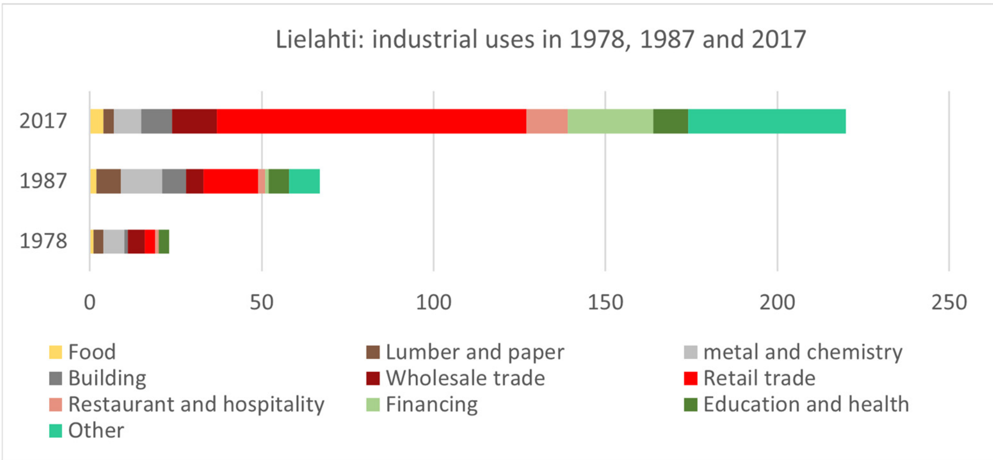

Figure 5. Number of uses and industries in Lielahti area have increased in time. Data from 1978 through 2017.

5.3. The Lahdesjärvi Process

In the local master plan, Lahdesjärvi is designated a survey area, and the partial master plan approved earlier in the 1990s remained in force in the area. However, in local detailed planning carried out in the 2000s, part of Lahdesjärvi was made to adhere to the demarcation large retail unit, justifying this by the fact that the first land use plan for the Tampere region used this demarcation for the area. The Lahdesjärvi partial master plan was completed in the fall of 2013. In this partial master plan, most of the area had been designated for commerce with extensive space requirements and for some workplace functions. In the wake of the Ikea store that opened in 2010, commercial and office premises have been built in the area, transforming the profile profoundly.

5.4. The Cases of University of Technology, University Hospital and Tohloppi Mediapolis

In the 2000s, local detailed plans had been created for two areas of high expertise: Tampere University of Technology (TUT (in 2018 united with University of Tampere)) in the suburb of Hervanta, and the Tampere University Hospital (TAYS). However, the development around these knowledge hubs was too brisk for planning to keep pace. Both the TUT and TAYS areas were not developed entirely in accordance with the local detailed plans, but projects were also launched under deviation decisions. These—sometimes massive—changes, such as a plan to locate an eight-story educational and office building in the University area for the use of private enterprises, were justified by the investor in the following manner:

> *"Along with the reformed Universities Act, the integration between the universities and the business world will increase, and it is therefore justified to locate such business activities at university campuses that synergically connect to the disciplines of the university concerned."* (Committee for City Planning and Infrastructure Services, 14 May 2013, Section 192)

It is noteworthy that both clusters of expertise have a public background. They provide higher education, carry out research, and benefit from networking with the business sector. The premises of these service clusters have been becoming more compact and versatile, as they are dependent on the formation of innovation environments. In these areas, the expertise and business activities are data and knowhow intensive and, at their best, reach the international level. Over the course of time, a significant number of jobs have been created in these areas, which sets a societal justification for rapid transitions and plan adjustments.

In addition, the Tohloppi public service television studio area has received a deviation decision allowing the transfer of art and communications education next to the Finnish Broadcasting Company in the fall of 2014. This "Mediapolis" is also a cluster of expertise and education that has a public background. In addition, the University of Tampere is following these examples in the city center.

5.5. Mixed Areas and Areas on Hold

For several old industrial areas mostly on the southern side of the city center, construction and development appeared to have ceased. These areas cover Hatanpää, Nekala, Sarankulma, and Lakalaiva industrial districts, and the zone along Nokiantie Road in western Tampere. Starting from the 1980s, the diversity of uses has gradually increased in these areas. Some plots are still used for manufacturing activities, adhering to their original purpose. On other plots, local detailed plan amendments have made it possible to increase the share of business premises in the original building stock. Some local detailed plans and deviation decisions have allowed space for leisure activities or cultural economic actors (for example, photographers, architects, artists, a circus school). Significant numbers of associations and a variety of small service enterprises using subcontracting operate in these increasingly mixed areas. For example, in Nekala, actors benefit from colocation with similar actors for collaboration and competition [36] (Figure 6). Small-scale clusters of specialized retail, services or industrial uses have appeared from such behavior. Simultaneously in the area, the number of actors has increased between 1982 and 2016 from 91 to 267.

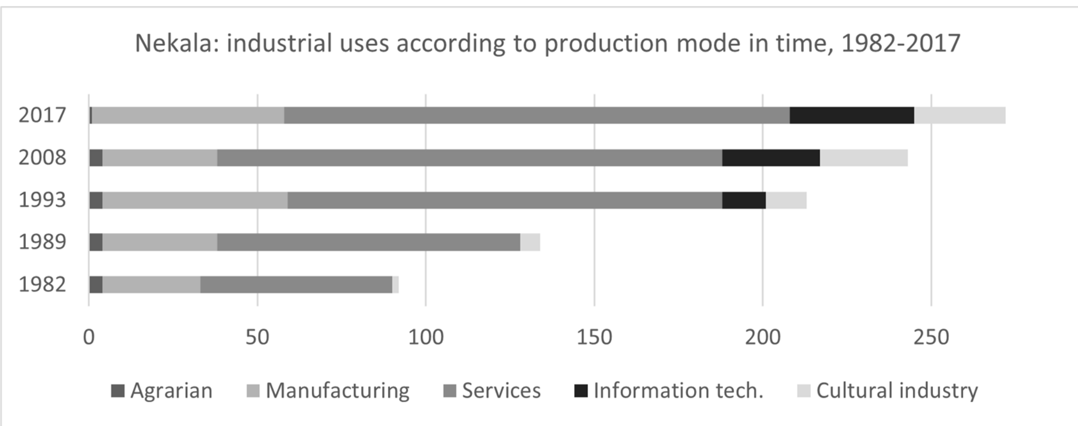

Figure 6. Increase and enriching of industrial uses in Nekala area 1982–2017. The diversification takes place almost entirely within the existing building stock.

Many plots in those areas are owned by investors expecting future revenues from an assumed increase in land value. This causes a lack of operator-oriented investments which forms the operational pattern of the construction activities in the inner-city, mature industrial areas outside the city center. On the basis of the local detailed plans studied, it appears that for the time being, the investors have settled for the rent yield that they receive from the old building stock. It is apparent that the development of the areas depends on the will of and measures taken by the City of Tampere.

The transformation sensitivity of these areas is indicated by the justification given in the application for a deviation decision for the Sarankulma area. Regarding the deviation decision applied for in 2013 to construct an office building along Ilmailukatu Street

> *"The value of the area has increased due to the proximity of the ring road and the Tampere Exhibition and Sports Centre, and it is currently better suited for the construction of office premises than for industrial and warehouse buildings. In addition, the plot has a prominent location along good connections, which is very suitable for this kind of building."*

5.6. Tampere City Center Is a Story in Its Own Right

The most recent partial master plan for the city center dates to 1995. This plan was approved by the Tampere City Council but was not ratified by the Ministry of the Environment. The city center has primarily developed by means of local detailed plans. A partial master plan for city center was ratified in 2016.

The local detailed plans and the plan amendments densified the urban structure in the city center. Business and accommodation premises were concentrated around the railway area, often by converting traffic area reservations to other uses. The local detailed plans also deemed decks and underground solutions viable. Two projects with significant impacts were the deck over the railway yard containing high-rise housing, hotel, offices and an ice-hockey arena, and the Ratina shopping center next to main bus station. Both are located in areas formerly designated as traffic areas in the city center partial master plan.

The city center was developing by means of local detailed plans specifically adapted to such projects through negotiations, and the launching of projects was slow. The high-profile projects in the city center needed to assemble a significant exterior funding base. Hence, the implementation of the projects was typically highly sensitive to economic fluctuations. The Tulli area, a 1970s office and industrial cluster at the very heart of Tampere city, is a good example of this slow pace.

An excerpt from the report of local detailed plan no. 7750 for Tulli (from 2002) enlightens this conditional financial situation:

> *"Preparations have been made for the construction of a hotel plot. It will probably be implemented soon after the local detailed plan has come into effect. If the local detailed plan is not in force in 2004, the project may have to be cancelled."*

This project was revised at the turn of the 2010s. After the completion of the plan and launch of the project, the development prospects for the surroundings of the plan area had significantly changed. Hence, the actors wanted to adapt the project to the landscape, which was enabled by the new local detailed plans. The actors therefore applied for a deviation decision.

Furthermore, in the city center, many local detailed plans were bound to the implementation of the traffic and transport system in the area (such as the light train system in progress). The share of public investments in the development of the city center has typically been large. Many of these are remarkably large projects with public and private partners.

6. Results

The results indicate that implementation of the building projects followed the local master plan only partially. The actual location decisions resulted from the urban actors in housing, services, and various industries seeking the most preferable locations for them. The flexibility they required from planning emerged either through negotiated, fragmented deviations on the plot level or from the fact that the site plans were tolerant enough to accommodate novel activities. Often, these gradual, incremental changes were consolidated afterwards by the means of a local detailed masterplan concerning only the district scale. We perceived that various forms of processes that could be considered self-organizing were guiding the activities' locations despite the local master plan. We classified these into three types of self-organizing processes and centralized or project-based initiatives implying a higher level of planning controls in the local master plan. The classification and features are presented in Table 2.

Table 2. Classification of perceived activities according to the types of self-organization related to the attractive features for the actors (location, other actors, one specific actor). These processes are enabled by certain planning maneuvers (deviation, tolerant plans or plans that meet the requirements as such), implying either proactive, reactive, or enabling mode of planning.

Activity Types	Actual Urban Processes	Mechanisms	Attraction for the Actor	Enabler	Planning Mode
working place areas	transforming sites	self-organization, one-scalar	location, accessibility	deviations	reactive
	Lielahti process	emergent self-organization	similar actors (competitors), location	deviations, partial plan	reactive
	on-hold areas	emergent self-organization	similar actors (competitors), location	loose plan	enabling
	knowledge centers	self-organization, point of attraction	a certain major attractor	deviations	reactive
mixed use	city center	negotiation: centralized planning/large scale projects	(location)	plan updates	proactive
	sub-centers	self-organization by location	location, accessibility, services	loose plan	enabling
housing	old residential areas	self-organization by location	location, similar actors	loose plan/deviations	enabling
	Master plan infill areas	centralized planning	none	top down	proactive
	attractive sites	self-organization by location	location	deviations	reactive

6.1. The Overview of Self-Organizing Processes

First, single-scale location-based self-organization took place in certain industrial areas, and for housing in sub-centers, old residential areas and attractive sites. It implied individual decision making by actors regarding the attractivity of the location (accessibility, quality of environment, vicinity of service nodes) and the patterns formed at the same scale than this decision. In this case, for example, the retail chose the preferable district, and the cluster appeared at the district scale. In these areas, which were often existing centers or old residential areas, the plans were tolerant enough or the maneuvers were implemented through deviations (deviations for retail justified by the Regional Plan, attractive locations for housing). These modes of planning could be considered either enabling or reactive, respectively.

Secondly, trans-scalar neighbor-based self-organization appeared in mature on-hold areas, where (in addition to location) actors had been attracted by ecosystems of other actors—either similar ones for competition or collaboration, or the diversity of adjacent neighbors for diverse services (e.g., accounting firms, lunch cafes). Here, site-level activity (relationship between adjacent neighbors) resulted in patterns that benefits the actors. For example, firms were drawn next to their competitor, eventually forming an activity cluster, a diversity hotspot on a level of a district (Figure 7). In these cases, actors' location decisions were enabled by a tolerant plan and/or deviations. The planning mode appeared mostly as enabling.

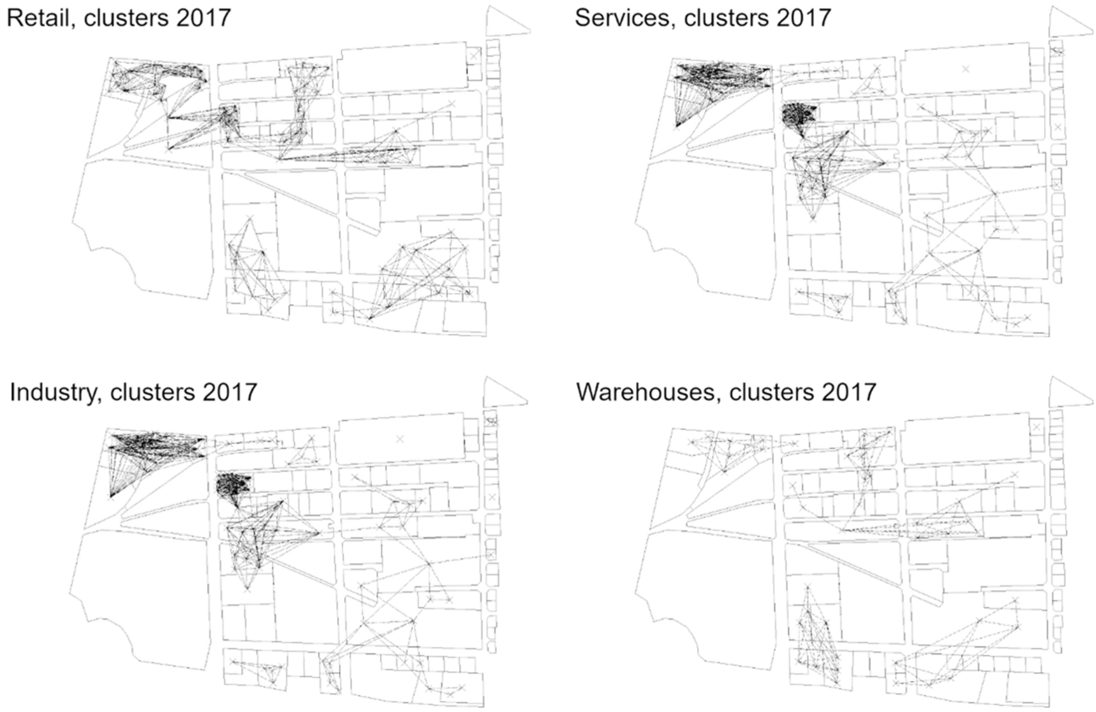

Figure 7. Examples of self-organizing clusters of uses in Nekala area, 2017. Clusters are formed by adjacent neighbors less than 50 m apart (local average block size).

Thirdly, self-organization around a point of attraction refers to cases where an existing, publicly funded center of knowledge such as the university, university hospital or the TV station was being developed by private actors, later attracting many companies to benefit from their proximity, forming a diverse hub of expertise. The self-organization was a combination of trans-scalar and single scale types: on the one hand, they gathered around a certain location characterized by the key actor. On the other, they benefitted from the vicinity of that actor, along with each other. Here, the swiftness of implementation was essential, and it was enabled by deviations from the master plan, and the projects were initiated by private actors and implemented after negotiations with the city. The planning mode was reactive.

6.2. Centralized Initiatives

There were two types of centralized planning or project-based initiatives. First, they concerned implementation of infill areas designated in the local master plan. Secondly, the large-scale projects in the city center often were joint ventures with private actors and strictly steered by planning, although concerning deviations from the masterplan. Traditional allocations reserving plots for infill made the mode for them proactive. However, the strategy had not been successful, leaving the implemented volume behind the objectives. For the more complex, externally funded city center, negotiation among actors and planners introduce a reactive tone to the planning process. This means that the city operates within the private investments and their development propositions but with a strong will to develop the whole center.

7. Discussion

By the early years of 2000, it was evident that cities had become extremely complex, unpredictable and largely autonomous systems, the planning of which appeared impossible with the traditional master planning instrument. A variety of approaches, many of which adopt a highly explanatory complexity theories of cities, have been proposed for tackling this uncertainty. However, it would be necessary to gain more empirical knowledge of the interrelations between traditional master plans and their implementation along with the resulting, emerging urban typologies and dynamics. This would help with developing practical planning in a more targeted manner. Here, we contribute to building such knowledge regarding a case study of Tampere, Finland.

Our results indicate that the implementation of building projects in Tampere followed the local master plan poorly. It appeared that the master plan as an instrument was incapable of anticipating the cumulative impact of individual actors' dissipated decision making. The problem was that for these processes, the overall urban spatio-functional dynamics was not guided on the level of the city or region, resulting in surprising patterns colliding with overall objectives of the master plan, such as new nodes of services, change of industrial profiles of the district, or shifts in population deviation. These processes produced some interesting phenomena, the mixed-use, diverse ecosystems in on-hold areas or nationally remarkable knowledge clusters. However, they also created turbulence in land values, traffic volumes, and investments that would have needed guidance and more predictability for viable urban development.

Moreover, we discovered a variety of actor-based processes that transformed the identities of areas gradually in a self-organizing manner. Different types of actors were attracted by a variety of multi-scalar factors ranging from location attributes and neighborhood relations to a certain major attractor. It appeared that such redundancy supporting the variability of actors was not encouraged but enabled by planning adjusting to the actors' needs via negotiation or contracts. This supported the different, partly overlapping ecosystems for agents with different needs, for example, actors in the same field, but perhaps differing in size, maturity, scale of action, assets, or company structure. However, a piece-meal planning results in a time-consuming and burdensome policy: each site plan deviation would require an individual planning process. While (often unintentionally) tolerant plans provided partial solutions, the system nevertheless lacked overall monitoring to evaluate their impact in regional urban economics and dynamics.

The complexity theoretical view enlightens the processes and results of this study well: dissipated decision making of actors and surprising trans-scalar patterns were discovered. Self-organization appeared as a key actor-based process probably helping the system to respond and adapt to nationwide and even global competition. Various types of areas that emerged despite the planning objectives formed ecosystems of actors networked with each other through contracts, competition and collaboration locally and at a wider scale. The guiding of such systems toward preferable directions necessary for societal and economic reasons would indeed require an attitude that resembles the planning of ecosystems in nature. A more profound connection and understanding of these ecosystems is needed in planning.

Hence, we suggest that in the planning of complex cities, certain aspects rising from complexity and resilience theories could be considered. These guidelines would concern both the overall, strategic spatial planning of cities (including scenarios, strategies, aims and goals), and faster processes of local level implementation (project monitoring, evaluation, and correction).

The key guidelines for planning for dynamic urban complexity would include:

1. Understanding the nature of urban systems and their complexity that is academically well established would be disseminated also in praxis, and embrace the uncertainty, self-organization, and unpredictable, autonomous nature of urban ecosystems;
2. Planning maneuvers that resonates with this understanding, learning from ecosystem planning. These would consist, non-exhaustively, of
    - Strict rules to restrict unpreferred phenomena to provide a "wind cover" for allowing the rest to operate, encouraging the diversity of actors regarding their industry but also the size, maturity, structure, and scope of operation. These rules could be higher scale, long-term strategic goals and scenarios; 'non-planning', i.e., purposeful refraining of maneuvers; contracts; and well-targeted laws and regulation;

- Tolerant attitude toward (1) the processes and (2) trial and error mode in planning. Hence, instead of megaprojects, one should prefer:
    - A (series of) small-scale implementation since they better enable constant monitoring and swift correction with minor loss; and
    - Appropriate (digital) tools to monitor and evaluate possible/preferable future paths, including, spatial information systems and procedural models; pattern recognition systems combining quantitative and qualitative methods and data; or micro-simulations. Many of these are or will be applying advanced AI, data mining and machine learning.

It is necessary to point out that for the continuity of the urban system, the planning should be both proactive (on the level of strategies and scenarios) and reactive (on the level of incremental implementations). The first one forms a slower cycle, providing longer term goals and aims at regarding overall socio-economic, ecological, and spatio-functional aims and objectives. These should form relatively statutory frames and be monitored infrequently. The second, faster cycle of project implementation, however, requires frequent monitoring, evaluation and intervention, to guide the emergent urban processes toward the set of strategic aims. In order to develop their master plans, certain Finnish cities are currently adopting systems of constant monitoring in planning (so-called continuous/rolling master plan [56]), the re-evaluation of which is tied to political election cycles. This is a step toward the right direction. However, strategic (politically justified) aims are under scrutiny every four years, implying the risk that the overall relatively steady frame becomes turbulent, making it also harder to evaluate patterns of implementation and their relationship to these perhaps transient objectives. Focus could be on the large-scale (strict but tolerant) regulation and the monitoring and guiding of actor dynamics and resulting patterns.

The major limitations of this research follow. First, that as a case study, it reflects only the local situation and context in Tampere city. To be generalizable, it would be necessary to carry out similar studies in different cities in Finland and elsewhere to know whether these findings result from this particular planning system. Secondly, this study reflects a certain period (late 1990s–2010s). After this evaluation, Tampere constructed a new master plan, intending to correct the discovered pitfalls. Another comparative analysis could reflect the impact of the new master plan to actor dynamics and their self-organization. Thirdly, in this qualitative study, we wanted to focus on better understanding the behavior of the urban ecosystem and recognizing types of self-organizing transition emerging from actors' decisions. The selected approach hence limits the knowledge based on quantitative measures, for example changes of uses according to floor area/percentages, area of land use change in square kilometers, changes in land prices, number of residents affected, or number of firms moving in certain districts were out of the scope of this study. We consider these as fruitful directions for future, complementary studies, along with surveys and interviews of actors (planners, decision makers in the city and in firms) to explore the motives of their actions. Such a multimethodological research would provide a multifaceted understanding of the phenomenon in either Tampere region or elsewhere.

For future studies, we consider it would be necessary to take a profound overview of planning policies and their underlying assumptions to understand the urban dynamics better: what kind of internal logics are implied in planning system and planners' thinking? How is the intrinsic uncertainty emerging from both systems' internal premises (actor dynamics) and external transitions (economic, social, health) considered in the planning system? This is a crucial question—this is apparent in pandemics, climate change, or socio-economic global crises, that are actualized on a local scale of cities: societies and cities are complex systems and should be explicitly treated as such also in planning.

8. Conclusions

In the wave of digitalization, cities are becoming increasingly complex regarding both their form and dynamics, often leaving urban planning powerless despite new technical tools. The emergent self-organization of cities is a key process for their viability, but it often collides with master plans relying on allocation of activities. Surprisingly little attention has been paid in urban research to evaluate this contradiction to develop planning that supports different forms of urban self-organization.

We scrutinized the degree to which the urban activities follow the spatio-functional objectives set in the general master plan in the case of Tampere. Furthermore, we explored and classified the types of self-organizing behavior recognized among urban actors and finally proposed guidelines for developing planning to support urban evolution and resilience. We discovered that the implementation deviated greatly from master plan objectives and was to a great extent resulting from various self-organizing processes. This is a crucial finding, since it proves that a rational planning praxis, even with communicative technological extensions or constant, partial updates of the master plan, is an inappropriate mode for planning the complex city in the flux. It appears incapable of steering the urban dynamics and might at worst restrict economic or cultural processes necessary for cities' and societies' operation.

This result indicates that profound changes in planning thinking is needed. Particularly, such planning for complexity should recognize, support, and guide the rich system of internal dynamics that took place either against or unintentionally allowed by the local master plan. These dynamics followed various forms of self-organization, such as emergent, location-based, and attraction-based self-organization, leaving the top–down initiatives to the minority. This is an important finding, since it is probable that such variance in and combination of forms of self-organization might be unique to each city and could be among forces making them viable. While probably all mature cities or "urban ecosystems" self-organize, they might follow their individual fingerprints in doing so, underlining the importance of scrutinization of local circumstances in planning process.

Consequently, the planning thinking capable of embracing such complex, emergent dynamics would need to abandon a strictly linear perspective of the process and move toward a dynamic, circular mode, applying novel (digital and other) methods for analyzing and evaluating the urban processes, while planning with small, experimental steps restricting only nonpreferable phenomena, and leave the rest of the urban processes intact.

This study builds on the currently limited understanding of colliding planning aims and dynamic urban process producing surprising spatial patterns affecting sustainable urban dynamics in complex cities. It enriches the approaches of so-called complexity planning by introducing an empirical case study and providing guidelines for the practical development of planning systems and their evaluation.

Author Contributions: Conceptualization, K.K. and J.P.; methodology, K.K.; analysis and interpretation, K.K. and J.P.; investigation, K.K. and J.P.; writing—original draft preparation, K.K. and J.P.; writing—review and editing, K.K. and J.P.; visualization, K.K. and J.P. All authors have read and agreed to the published version of the manuscript.

Funding: This work was supported by the Academy of Finland, Strategic Research Council [grant number 303618].

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable for plans. During the study, no data were acquired; the plans and related documents on which the results are based were scrutinized on the premises of City of Tampere under a special contract. GIS analyses results including republished images 2 and 3 are available https://www.tampere.fi/sites/default/files/2022-06/Yk1998_ajantasaisuuden_arviointi.pdf (accessed on 1 November 2022) (in Finnish).

Acknowledgments: We would like to sincerely thank City of Tampere and particularly the Head of Master Planning Pia Hastio for support and enabling this study.

Conflicts of Interest: Kaisu Kuusela has previously worked for the City of Tampere and participated in the data exploration as an employee.

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